Current and emerging techniques for contaminant mapping and data visualization at DNAPL sites

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Current and emerging techniques for DNAPL site characterization in sediments and fractured bedrock

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Recent advances in the development of contaminant specific site investigation tools has significantly enhanced our ability to characterize the spatial architecture of DNAPL source zones in both sedimentary and fractured bedrock environments. The application of innovative site characterization methods will be discussed in the context of contaminant delineation, remediation design, technology verification and regulatory acceptance.

We present a range of site investigation tools, based on the principle of combined lines of evidence and the premise that a single technique is not available to fully delineate DNAPL distribution in the subsurface. Key to this strategy is the selection of technologies with multiple scales of measurement and data quality, of which there are two main categories. The first category provides qualitative, dense spatial data, often with higher detection limits over a preset value. These methods are generally of lower cost, produce vertical profiles of real-time data and are primarily used to identify site areas that require further investigation. Examples of such "decision quality" methods are drive point tools, such as laser-induced fluorescence profiling and membrane interface probing in unconsolidated sediments, and the NAPL FLUTe^{TM} system in fractured bedrock. These first category methods produce qualitative data that are used to guide the sampling strategy for the application of the second category of technologies that are typically compound-specific and generate quantitative, precise data that have low detection limits. Examples include the use of fully cored boreholes (and associated subsampling) and high resolution multilevel well completions. Where these two categories of measurement technologies are used in tandem, a more complete and accurate dataset is achieved and additional site mobilizations are limited. These second category methods tend to be higher cost with longer turnaround times that preclude on-site decision making, hence applying them to quantify, rather than produce a conceptual model, facilitates a key cost saving.

The use of this ‘toolbox’ approach is described for a comprehensive fractured bedrock case study in Denmark (funded by the Capital Region of Denmark), where a chlorinated solvent DNAPL has impacted underlying glacial till fractured limestone bedrock. The findings of the study and recommendations for future investigations will be discussed in the context of published literature and current and emerging best practice guidance.